§66. Ion Temperature Rise in Electron-ITB Plasmas Formed with Combination of ECH and NBI

Takeiri, Y., Morita, S., Ikeda, K., Ida, K., Tsumori, K., Oka, Y., Osakabe, M., Nagaoka, K., Kaneko, O.

The increase in the ion temperature due to transport improvement has been observed in plasmas heated with high-energy negative-NBI, in which electrons are dominantly heated, in Large Helical Device (LHD). When the centrally focused ECH is superposed on the NBI plasma, the ion temperature rises, accompanied by formation of the electron ITB. This is ascribed to the ion transport improvement with the transition to the neoclassical electron root with a positive radial electric field.

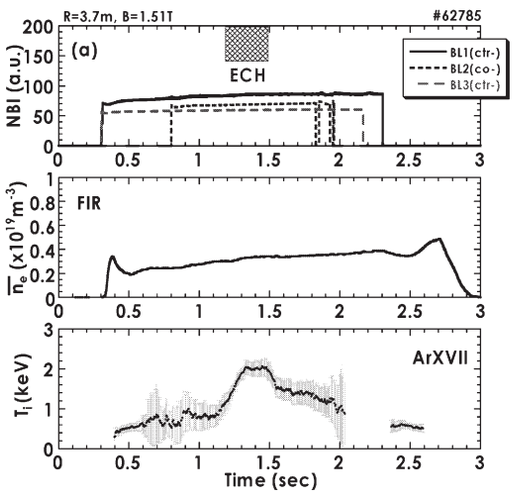

Fig. 1. Time evolution of the electron density and the ion temperature in an NBI+ECH plasma.

Figure 1 shows the time evolution of an NBI+ECH plasma. With superposition of the centrally focused second-harmonic ECH on a plasma heated with high-energy negative-NBI (>150keV, H), the central T_e is increased, and the electron ITB, which indicates a steep gradient in a core region, is formed in LHD [1]. Simultaneously, the central T_i is also raised with the superposition of the ECH, as shown in Fig. 1. The electron ITBs in helical systems are characterized by improvement of the core electron transport due to the neoclassical electron root, which is in contrast with the tokamak's ITBs. The neoclassical calculation shows the formation of positive radial electric field (E_r) in the core region in the electron ITB plasma, in which the transport improvement of both ions and electrons is theoretically predicted. Figure 2 shows the radial profile of T_e measured with Thomson scattering, and those of T_i and E_r measured with CXRS, for an electron ITB plasma and a non-ITB plasma. A positive increase in the E_r is observed in a core region with the superposition of the ECH, as shown in Fig. 2(c), and an increase in the T_i is also observed, as shown in Fig. 2(b).

Since the electron density profile is not changed with the superposition of the ECH, the NBI absorption power and profile are not so changed. Considering that the increase in the ion heating power ratio is as small as around 10% due to an increase in the T_e and that the heat exchange between the electrons and the ions is negligible, the ion temperature rise is ascribed to the improvement of the ion transport in the core electron root.

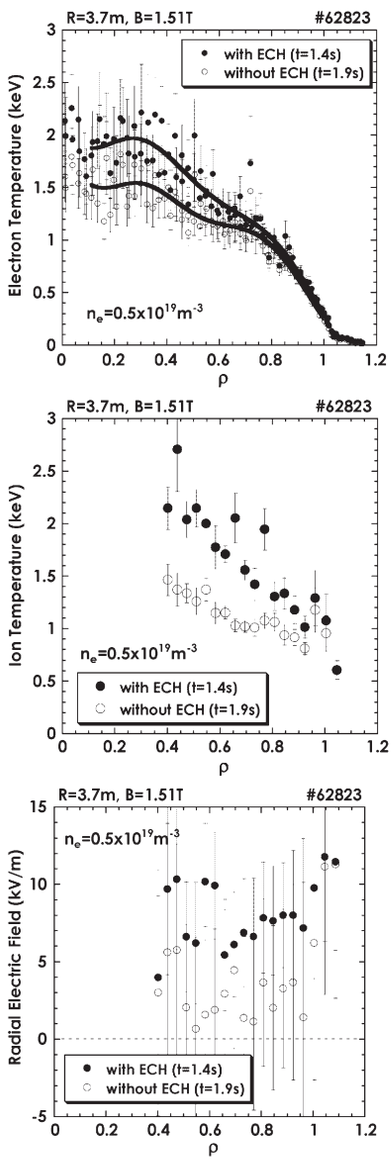

Fig. 2. Radial profiles of (a) T_e, (b) T_i, and (c) E_r for the electron ITB plasma and the non-ITB plasma at R_{ax}=3.7m.

References

[1] Y. Takeiri *et al*, Phys. Plasmas **10** (2003) 1788.